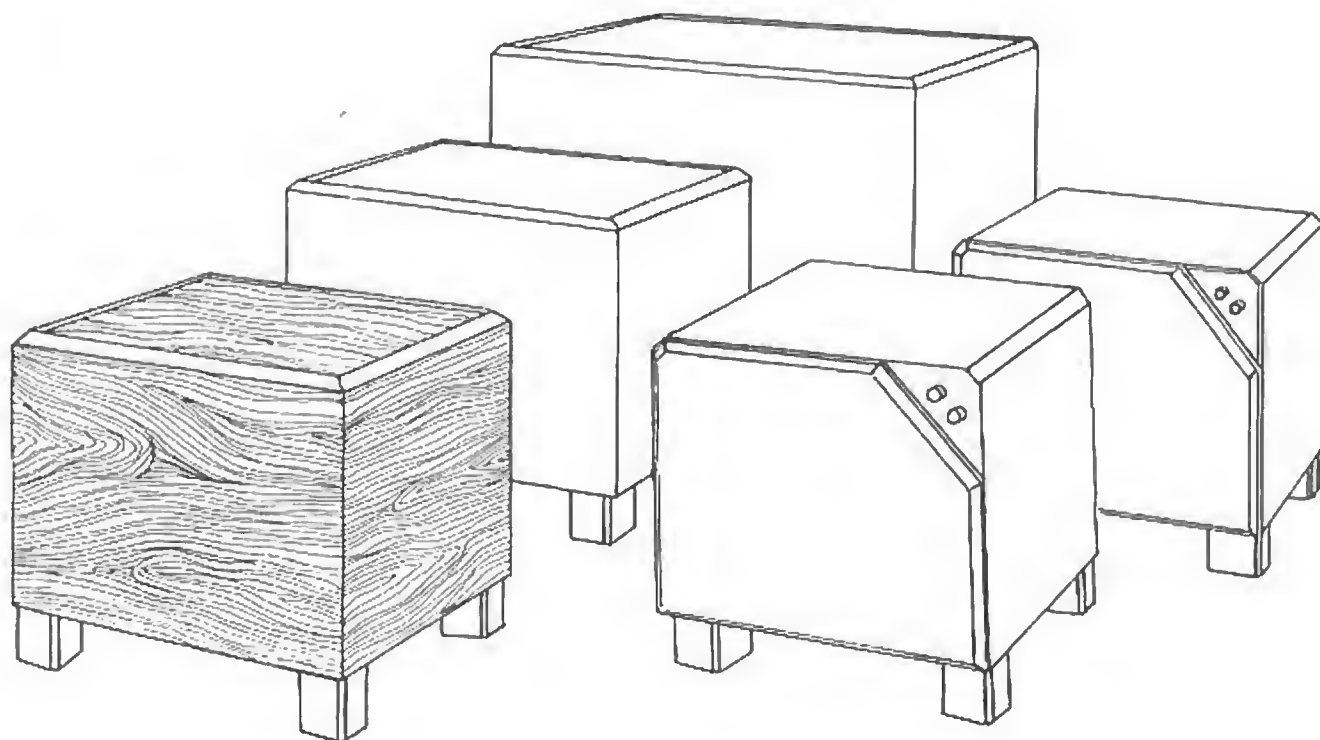


Velodyne

OWNER'S MANUAL

ULD-12 Subwoofer System



SAFETY INSTRUCTIONS



CAUTION: To reduce the risk of electric shock, do not remove cover (or back). No user-serviceable parts inside. Refer servicing to qualified service personnel.

The lightning flash with arrowhead symbol, within an equilateral triangle, is intended to alert the user to the presence of uninsulated "dangerous voltage" within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the appliance.

1. **Read Instructions** — All the safety and operating instructions should be read before the appliance is operated.
2. **Retain Instructions** — The safety and operating instructions should be retained for future reference.
3. **Heed Warnings** — All warnings on the appliance and in the operating instructions should be adhered to.
4. **Follow Instructions** — All operating and use instructions should be followed.
5. **Water and Moisture** — The appliance should not be used near water — for example, near a bathtub, washbowl, kitchen sink, laundry tub, in a wet basement, or near a swimming pool, and the like.
6. **Carts and Stands** — The appliance should be used only with a cart or stand that is recommended by the manufacturer.
7. **Wall or Ceiling Mounting** — The appliance should be mounted to a wall or ceiling only as recommended by the manufacturer.
8. **Ventilation** — The appliance should be situated so that its location or position does not interfere with its proper ventilation. For example, the appliance should not be situated on a bed, sofa, rug, or similar surface that may block the ventilation openings; or, placed in a built-in installation, such as a bookcase or cabinet that may impede the flow of air through the ventilation openings.
9. **Heat** — The appliance should be situated away from heat sources such as radiators, heat registers, stoves, or other appliances that produce heat.
10. **Power Sources** — The appliance should be connected to a power supply only of the type described in the operating instructions or as marked on the appliance.
11. **Power-Cord Protection** — Power-supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, convenience receptacles, and the point where they exit from the appliance.
12. **Cleaning** — The appliance should be cleaned only as recommended by the manufacturer.
13. **Nonuse Periods** — The power cord of the appliance should be unplugged from the outlet when left unused for a long period of time.
14. **Object and Liquid Entry** — Care should be taken so that objects do not fall and liquids are not spilled into the enclosure through openings.
15. **Damage Requiring Service** — The appliance should be serviced by qualified service personnel when:
 - a. The power-supply cord or the plug has been damaged; or
 - b. Objects have fallen, or liquid has been spilled into the appliance; or
 - c. The appliance has been exposed to rain; or
 - d. The appliance does not appear to operate normally or exhibits a marked change in performance; or
 - e. The appliance has been dropped, or the enclosure damaged.
16. **Servicing** — The user should not attempt to service the appliance beyond that described in the operating instructions. All other servicing should be referred to qualified service personnel.

For Your Records:

Serial Number _____

Date of Purchase _____

Name of Store _____

OWNER'S MANUAL

VELODYNE ULD-12 SUBWOOFER SYSTEM

Congratulations on your purchase of a Velodyne ULD-12 Subwoofer System. This system represents the state of the art in accurate bass reproduction. Read and follow the instructions below to insure safe and proper system operation. Save this manual for future reference.

Warning: To prevent fire or shock hazard, do not expose this equipment to rain or moisture. To avoid electrical shock do not open speaker enclosure or amp chassis cover. Please observe all warnings on the equipment itself. There are no user serviceable parts inside. Please refer all service questions to your authorized Velodyne dealer.

Prior to installation: Please unpack the system carefully. Remove all staples used to seal the carton as they can scratch the cabinet. Please save the carton and all packaging materials for future use. Record the serial number in the space provided above and both locations on the warranty card for future reference.

INSTALLATION

Your new ULD-12 subwoofer system provides for a number of installation options. Read all the installation information below in order to determine which installation option is best for your system. *Remember to perform all installation procedures with system power turned off.*

Inputs. The ULD-12 is equipped with both speaker-level and line-level stereo inputs. Use the LINE IN jacks when connecting your subwoofer to a pre-amp, signal processor, or line-level crossover. The FROM AMPLIFIER jacks connect directly to the speaker outputs of your integrated amplifier or receiver. Your amplifier section will notice no additional loading effects when you use these inputs because of their high impedance.

NOTE: Do not use both line and speaker level jacks simultaneously.

High Pass Crossover. Because your satellite speakers cannot reproduce bass as accurately as the ULD-12, optimum system performance is attained by rolling off the low end response of your satellites. The ULD-12 is equipped with a high pass crossover for this purpose. To use the crossover, simply drive your power amplifier or satellites from the ULD-12's outputs.

Interconnection Cables. When installing your ULD-12 using FROM AMPLIFIER and TO SPEAKERS (as in Figure 1) run the same quality speaker cable to your subwoofer as you do to your satellites. If the speaker level cables to your ULD-12 will not be driving any satellites, then a medium gauge "zip cord" is sufficient to supply the subwoofer alone.

Line level cables should be standard shielded phono cables. Always keep leads between your pre-amp and power amplifier as short as possible.

INSTALLATION OF ULD-12 USING FROM AMPLIFIER INPUTS

Figure 1 shows how to connect your ULD-12 to a receiver or integrated amplifier. When using the speaker level terminals, note the right and left channel designations above the terminals. Red speaker jacks are positive, black speaker jacks are negative (common).

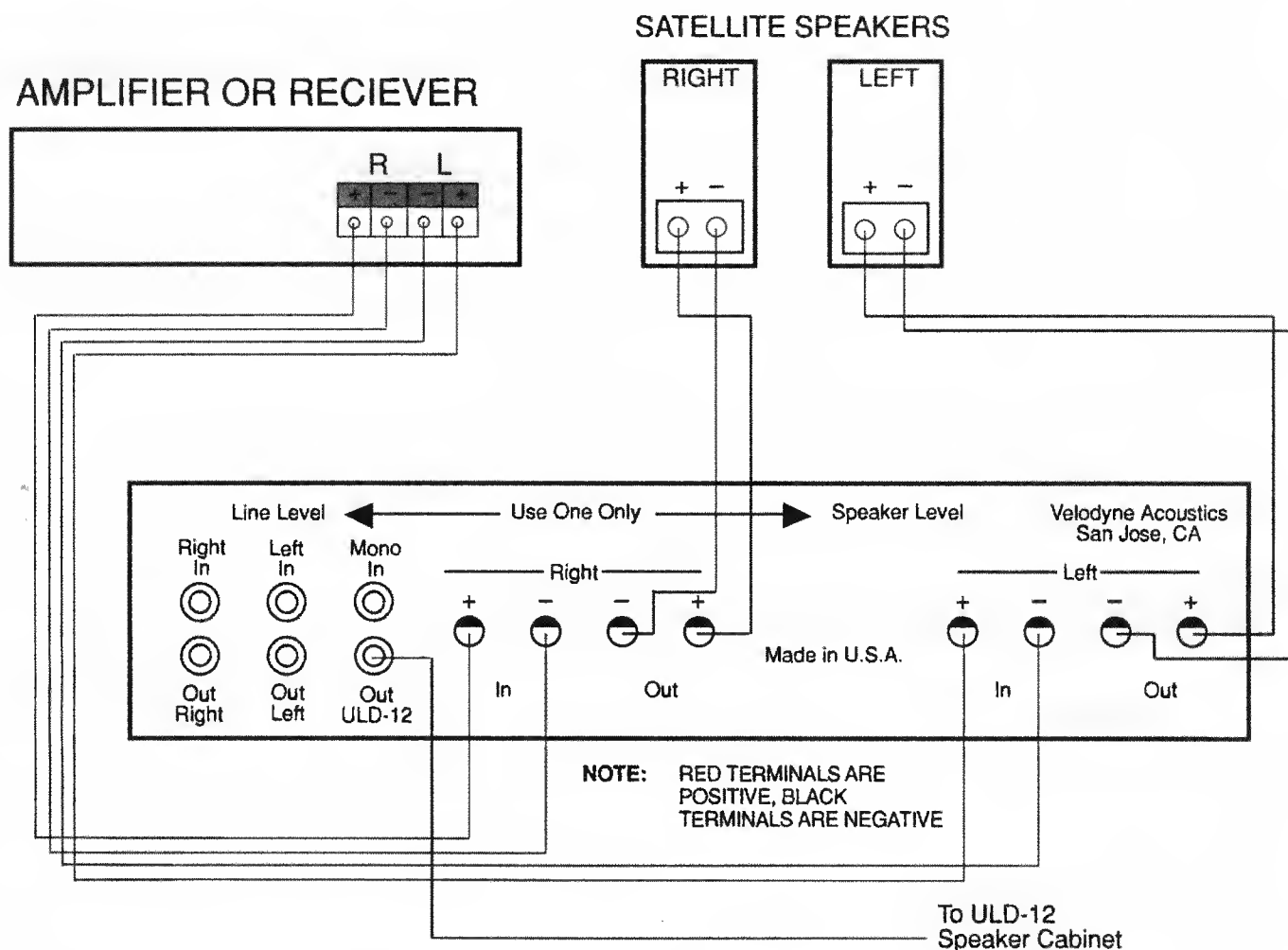


Figure 1: Installation Using FROM AMPLIFIER Inputs

Caution: To avoid damage to your main amplifier be sure to make all speaker connections from RED (positive) to RED and from BLACK (negative) to BLACK. Be sure that all connections are tight, and that there are no loose strands or frayed wires.

INSTALLATION OF ULD-12 USING LINE INPUTS

Figure 2 shows how to install your ULD-12 between a pre-amplifier and power amplifier. If you are connecting to the monaural subwoofer output of a surround sound decoder, then run a single phono cable from the decoder's sub out to the MONO IN jack on the ULD-12 controller. Leave the unused input and both outputs disconnected.

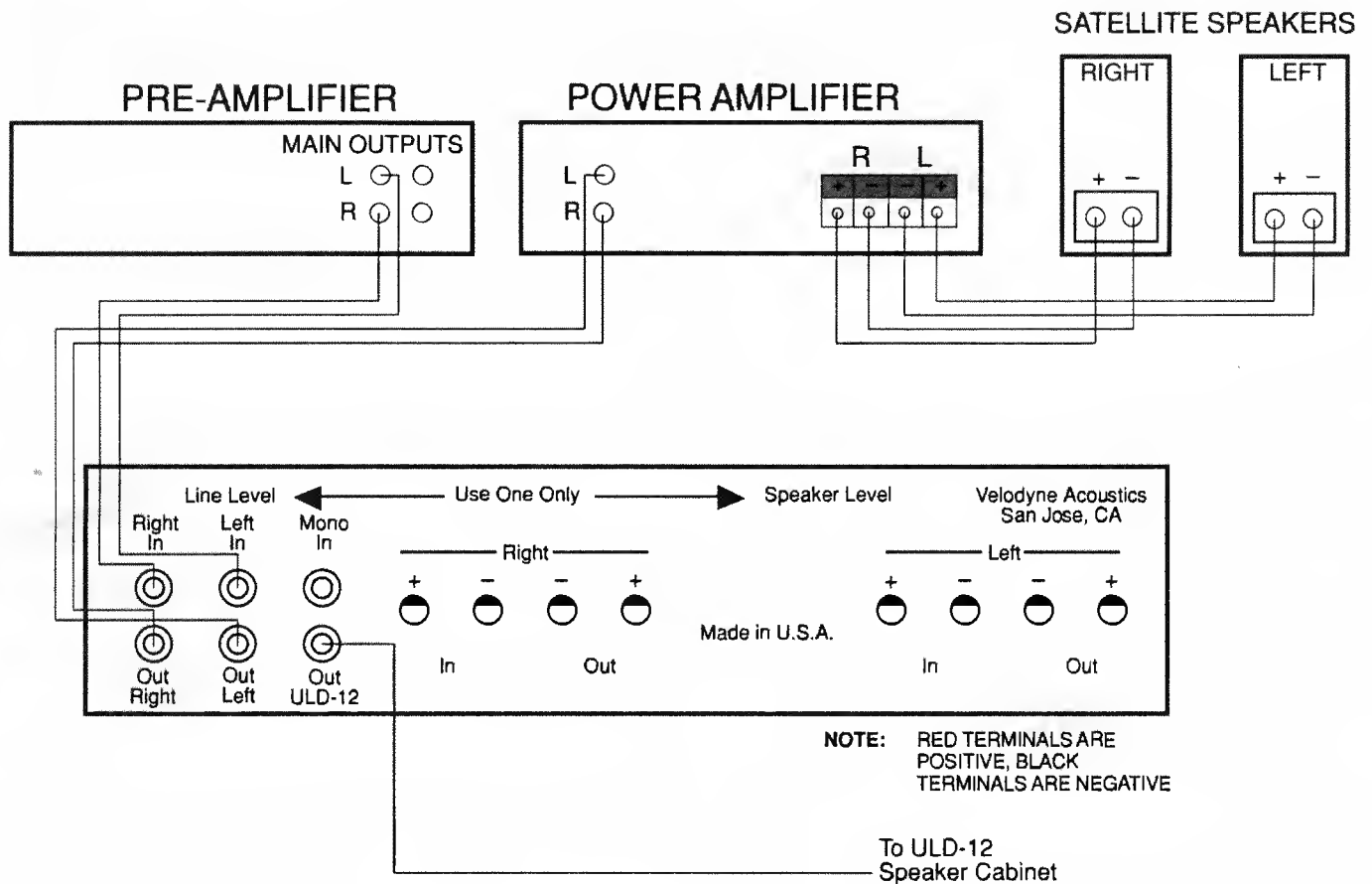


Figure 2: Installation Using LINE Inputs

PLACEMENT

The ULD-12 operates primarily at frequencies below 85 Hz. These frequencies are essentially non-directional such that you may place the subwoofer almost anywhere without degrading the stereo imaging characteristics of your main speakers.

When using a pair of ULD-12s in stereo, it may be preferable to place each subwoofer adjacent to the satellite of the same channel.

Keep in mind that frequency response and output level can be greatly influenced by placement, depending on the acoustic properties of the listening room. Typically the ULD-12 will sound louder next to a wall or in a corner.

Caution: The ULD-12 amplifier is built into the woofer cabinet. Do not place cabinet next to sources of heat such as furnace registers, etc. The power cord should be routed in such a way that it will not be walked on, pinched, or compressed.

CONTROLS

The control panel on your ULD-12 includes a power switch, a power-on indicator lamp, and a level control.

The subwoofer level control knob is used to adjust the volume level of bass information in relation to the midrange and treble frequencies. We recommend that you begin listening with the level set at the point midway between MAXIMUM (fully clockwise) and MINIMUM (fully counter-clockwise). Play several selections of music and vary the subwoofer level until the bass matches the mids and highs to your satisfaction. Once you set the subwoofer level, you simply use your system's main volume control and the bass proportion will remain consistent.

CARE OF YOUR SUBWOOFER

We recommend using a clean damp cloth for cleaning the cabinet. Never use detergents or abrasives on your ULD-12.

The ULD-12 may be left on continuously without fear of long-term adverse effects. We do recommend that you turn off the unit during extended periods of nonuse.

PROTECTION CIRCUITRY

Your ULD-12 is equipped with a special circuit designed to protect the unit from damage. Either of the two conditions below will power the unit down and keep it off for 5 seconds after the fault is corrected.

- 1) If there is a significant drop in the line voltage.
- 2) If there is an input signal which momentarily exceeds the dynamic range of the unit.

TROUBLESHOOTING / SERVICE

Before seeking service for your ULD-12, please re-check all system and power connections. Also consider the protection circuit described above; you may only need to turn the volume down slightly.

If you determine that your unit requires service, then please contact your local Velodyne dealer.

The following conditions *always* require service by qualified personnel:

- 1) If the power cord or speaker connecting cable is damaged
- 2) If the unit does not appear to operate normally or exhibits a marked change in performance
- 3) If the unit has been exposed to water

VELODYNE HGS SYSTEM

Velodyne's prime focus is in providing low distortion loudspeaker systems that impress the dedicated audio-ophile as well as the casual listener. Velodyne developed its patented High Gain Servo (HGS) system to bring nonlinear distortion down to unprecedented levels on its ULD-15 and ULD-18 high performance subwoofers. Your new ULD-12 uses this same HGS technology to reproduce the music you enjoy without the excessive nonlinear distortions that plague conventional loudspeaker designs.

The Problem of Distortion

Nonlinear distortion is defined as any form of distortion that moves energy from one portion of the audio frequency spectrum to another. When a single tone is applied to a nonlinear system, the result is harmonic distortion, in which some of the energy leaves the system at integer multiples of the original input frequency. When multiple tones are applied to the same system, intermodulation tones are produced, usually as simple combinations of the input frequencies, i.e., sums and differences of integer multiples of the applied tones. In general, 3% nonlinear distortion is considered a reasonably small amount. This means that 3% of the total energy leaving a loudspeaker is at frequencies other than the intended pure tone applied to the input. Our tests, however, indicate that about 0.5% nonlinear distortion at normal listening levels must be achieved before the average listener is truly affected by an improvement in bass response.

In the reproduction of deep bass notes, loudspeakers suffer from a "double-whammy" when it comes to nonlinear distortion. First, most loudspeakers have much more than even 3% THD (Total Harmonic Distortion) at

low frequencies. Even at 1 watt drive levels, many loudspeakers have 8 to 10% THD at 40 Hz. With the 50 watt drive levels needed to produce realistic bass intensity, these distortion figures rise to astonishing levels. Second, the distortion products produced by a nonlinear woofer are much easier to hear than is the fundamental frequency. Consider a speaker driven at 30 Hz with 5% 3rd harmonic distortion. If the 30 Hz tone is 90 dB SPL (Sound Pressure Level), equating to about 5 watts into a typical woofer, the 3rd harmonic, at 90 Hz, would be down 26 dB, or at 64 dB SPL. However, humans are more than 10 times as sensitive to sound at 90 Hz than at 30 Hz. The nonlinear distortion produced by a woofer must be weighted by the sensitivity function of the human ear. When this is done, it becomes clear that even a small percentage of harmonic distortion is unacceptable in a bass driver. It is also clear that high-order (3rd, 4th, 5th, etc.) harmonic distortion products are more serious than are 2nd harmonic distortion products. These studies have led to the conclusion that 0.5% is the maximum tolerable amount of nonlinear distortion for a bass driver, and the less distortion the driver produces, the more capable it is of accurately reproducing live sounds.

Since most woofers today have at least 10% THD when 0.5% is the maximum tolerated, minor improvements in woofer technology are essentially ineffective. Servo Series Subwoofers have about 90 times less nonlinearity than a typical 10 inch bookshelf speaker. They have about 3 times less distortion due to their greater size and power handling capability, and about 30 times less distortion due to the Servo feedback loop. The improvement is even greater if one considers exceptionally loud and deep tones such as organ pedal notes.

An interesting result of this reduced distortion is that much of the bass, when played over a servo Series Subwoofer, seems to actually be reduced. The truth, of course, is that the "missing" bass was never really there on the source material, and was never intended to be played by the artist. Distortion products introduced by conventional woofers actually make the entire bass spectrum sound louder.

Our Solution

The Velodyne Servo Series Subwoofer System produces sound in the same manner as any conventional loudspeaker: a cone-shaped piston is forced to move by means of a linear motor composed of a coil situated between the poles of a very strong permanent magnet. In the Servo Series, however, this linear motor is a servo-motor, meaning that the motor is linked to the power amplifier as part of a control system. The basis for the control action is the signal obtained from an accelerometer which is rigidly fastened to the voice coil. The strategy of continuously monitoring the cone motion, and using this information as the basis for the corrective action, is called motional feedback. This feedback technique is illustrated in the system block diagram, Figure 4.

The signal into the system is a time varying voltage which is an exact analog of the desired acoustic output from the loudspeaker. The accelerometer output contains sufficient information to deduce the actual acoustical output of the woofer. The servo circuitry compares almost instantaneously how well the acoustic output matches the command signal coming in. If and when there is a deviation, the servo circuitry modifies the drive signal to the amplifier so that the acoustic output from the speaker is a true representation of the input.

In conventional loudspeakers, the drive signal into the speaker is virtually free from distortion but the speaker's acoustical output may be highly distorted. In Servo Series Subwoofers, the speaker coil drive signal is often highly distorted, or actually pre-distorted, in exactly such a way that the acoustical output from the speaker is free from distortion. Motional feedback has been used previously in an attempt to make small woofers sound like larger, more powerful ones. At Velodyne, the use of motional feedback is applied to make what is already a large and powerful woofer achieve a level of performance that has never before been reached in a home entertainment product.

HGS System Components

High and Low Pass Crossovers receive the incoming audio signals from your system pre-amp or power amp. Frequencies above 85 Hz are diverted to your power amplifier while frequencies from the right and left channels below 85 Hz, are summed to monaural and passed on to subsequent stages in the subwoofer.

Loop/Control Stage. Incoming bass signals pass through a variable gain amplification stage designed to protect the subwoofer from being overdriven (see Supporting Circuits below). With a bit of added filtering, the bass signal is now ready to be compared with the feedback signal of the accelerometer. A composite signal is created which compensates for erroneous movement of the cone.

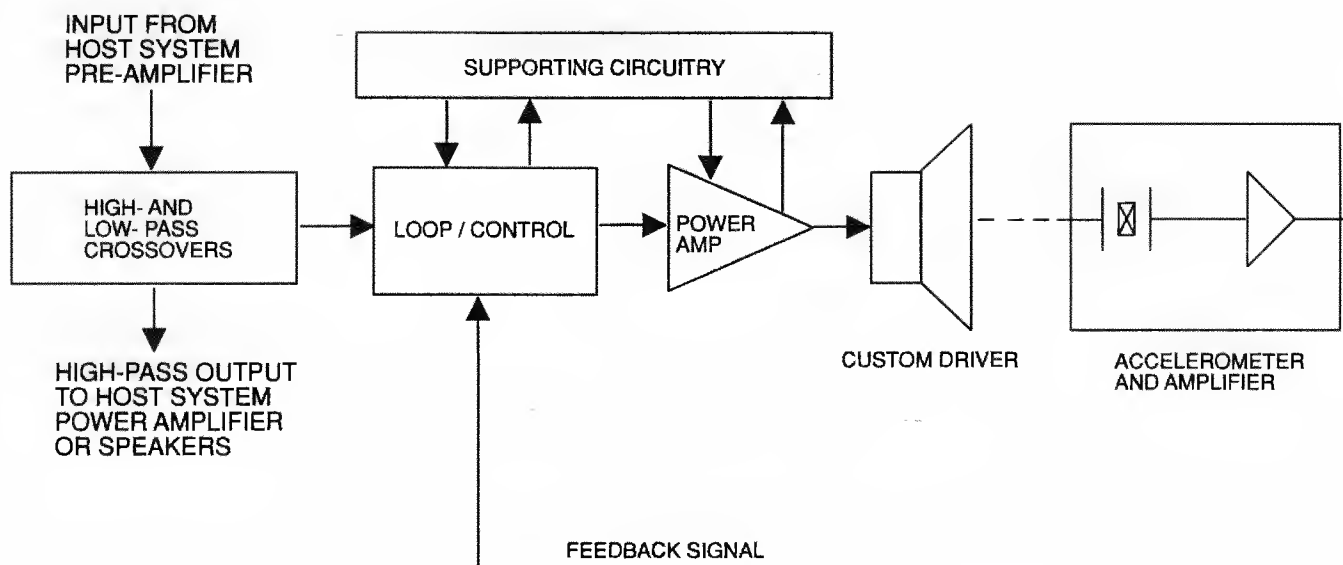


Figure 4: Servo Series System Block Diagram

Power Amplifier. The ULD-12 amplifier must provide power for distortion correction as well as basic music reproduction.

Custom Driver. Although our HGS electronics play the most important role in reducing distortion, the Servo Series driver must be carefully engineered and constructed so as not to undo the work that the HGS electronics have done. A large magnet and voice coil are used to improve sensitivity, the cone is specifically shaped to reduce resonances, and ventilation holes are used liberally to eliminate whistling noises often associated with long-travel operation (essential for producing low frequencies at listenable volumes).

Accelerometer. Perhaps the most critical component of the HGS system, the accelerometer measures the motion of the cone and relays it back to the loop circuits by means of an onboard charge amplifier and special feedback circuitry.

Supporting Circuits. A GAIN COMPRESSION circuit evaluates the amplitude of the incoming bass signal. The gain compressor is directly linked to the control stage and can thereby limit input signal gain in order to prevent amplifier clipping. If an extremely loud transient is detected, the gain compressor circuit will signal the COMPARTOR circuit to immediately shut down the subwoofer's power amplifier for five seconds. The comparator circuit will also shut down the power amplifier if it detects problems with the power supply.

VELODYNE, ULD-12, ULD-15, and ULD 18
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VELODYNE ULD-12™

SUBWOOFER SYSTEM SPECIFICATIONS

Amplifier

Type: Integrated Class B.
Power: 100 watts continuous RMS, 400 watts peak
Stereo Input: Line level sensitivity – 100 mV /10K nominal
Speaker level sensitivity – 1 volt nominal

Driver

Diameter: 12 inches
Linear travel: $\frac{9}{16}$ " peak to peak
Voice Coil: Copper; $2\frac{3}{8}$ " Diameter, 1.1" Length
Magnet: 56 oz.
Cone: Resin impregnated fiber
Accelerometer: Piezo with integral amplifier

Crossover

High Pass: Passive, 85 Hz nominal. 6 dB per octave
Low Pass: Active, 85Hz, 12 dB per octave

Cabinet

Finish: Oak, Walnut Veneer – Black
Dimensions: (L) 22 $\frac{1}{2}$ ", (W) 17", (H) 18 $\frac{1}{4}$ "
Weight: 49 lbs.

Servo

Servo Loop Gain: 26 dB
Servo Loop Feedback Rate: 3500 corrections per second
Maximum Distortion (25 Hz @ 104 dB): <.5%
Frequency Response: 20 Hz low, 85 Hz high
Driver Resonant Frequency: <4 Hz
Damping Factor: >1000
Protection: Low Voltage, Excessive Signal
Warranty: 2 years

Specifications are subject to change without notice.